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ABSTRACT

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Variability in Teachers' Responses to Standards-based Mathematics Reform

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Paper presented at the annual conference of the American Educational Research Association in San Diego. April, 1998.

Abstract

Motivated by three separate policies (Goals 2000: Educate America Act of 1994, Colorado's Education Reform of 1993 "House Bill 1313", and the Standards of the National Council of Teachers of Mathematics), Colorado school districts are grappling with implementation issues surrounding mathematics standards. Teachers in two school districts, differing in socio-economic status, district size, and setting, participated in this study of how standards-based reform impacted their curricular and instructional practices. Over thirty interviews and classroom observations, and numerous district and classroom documents produced the qualitative data for domain analyses. Results indicate that there is great variability among teachers' perceptions of standards-based reform, and that this variability is reflected in their classroom practices. Many teachers interpreted the reform as a requirement for surface level changes, and followed through with classroom changes such as reorganizing and fine-tuning the curriculum. A few teachers understood standards-based reform to be more complex, but usually their reform efforts were diminished by other pressing problems.

Since Sputnik in the 1950s and A Nation at Risk (National Commission on Excellence in Education, 1983) in the 1980s, the quality of education has come under near constant challenge. Standards-Based Education (SBE) is the 1990's version of a series of reform policies intended to improve schools. SBE, as used in this paper, is a program of instruction focused on student learning of content standards and aligned with assessments appropriate for measuring those content standards (Colorado Education Reform of 1993). SBE policies consist always of ambitious curricular goals, usually of assessments, and occasionally of resources. Issues related to SBE occupy the professional literature in education, popular media, and political agenda. To date, however, the evidence that SBE bears fruit is limited.

SBE policy in Colorado has three sources: National Council of Teachers of Mathematics (NCTM) documents (1989, 1991), federal education policy (Goals 2000: Educate America Act, 1994) and state education policy (Colorado Education Reform of 1993). Each of these sources has put forth a different type of policy instrument (McDonnell & Elmore, 1991) with varied levels of authority, detail and financial support.

The NCTM documents, authored by the major professional organization of K-12 mathematics educators, have only moral authority. NCTM relies on professional norms and the power of persuasion to implement the reform. In its precedent-setting document of standards, NCTM identified mathematics content standards for K-12 students and teachers. For example, NCTM's standard related to patterns and functions for middle school states:

> In grades 5 – 8, the mathematics curriculum should include explorations of patterns and functions so that students can:
> - Describe, extend, analyze, and create a wide variety of patterns;
> - Describe and represent relationships with tables, graphs, and rules;
> - Analyze functional relationships to explain how a change in one quantity results in a change in another;
> - Use patterns and functions to represent and solve problems.
>
> (NCTM, 1989, p. 98)

However, NCTM did much more than just identify the content to be learned. NCTM also articulated a fundamental change in expectations of what happens inside a mathematics classroom and a change in the spirit in which mathematics should be taught. These documents provide a complete vision of the philosophy and comprehensive scope of mathematics education reform,

and specify instructional and assessment improvements that must accompany curricular changes. NCTM states:

> Any program can be implemented by degrees. At one level, the language of the new program can be adopted while day-to-day instruction remains unchanged. At another level, minor changes in structure can be made by inserting a new unit into a course or slightly modifying the scope and sequence. At a third level, deep structural changes can be made that include altering how people think about a program, how mathematics is presented, and how students come to know mathematics. The Standards speaks to this third level of change. (NTCM, 1989, p. 237)

Numerous leading educators advocate NCTM's emphases on upgraded curricula, pedagogy and assessment. Advocates assert that reform must be systemic, involving high-quality instruction in schools and resulting in higher levels of achievement for all students (O'Day & Smith, 1993; Smith, Fuhrman & O'Day, 1994). Further, they argue that increased levels of teacher knowledge of mathematics, new beliefs about how students learn mathematics and revision of teachers' perceptions of their role in the classroom are all components of the reformed SBE system (Cohen & Ball, 1990). Supporters insist that successful reform will necessarily involve much more emphasis on higher-order thinking. Higher-order thinking requires more than just information retrieval; it consists of "deep understanding" which is non-algorithmic, complex, interpretive and effortful (Baker, 1990; Romberg, Zarinnia & Collis, 1990; Resnick & Resnick, 1992).

Goals 2000, the federal policy instrument, is an inducement policy tool (McDonnell & Elmore, 1991) that the federal government uses to encourage states and districts to pursue SBE. Goals 2000 does not carry the legislative authority to mandate compliance; instead it offers federal seed money (albeit limited) to state and local units to gain their participation.

The state policy instrument, Colorado Education Reform of 1993 (also commonly referred to as House Bill 1313), is a mandate in McDonnell and Elmore's terms. As such, it requires that all Colorado school districts and the Colorado Department of Education comply and legislates deadlines for the completion of specific activities. This mandate does not provide financial resources to the school districts to implement reform activities. Both the federal and state policies are specific about the ends they envision but vague about the means of getting there.

Research on Change in Education

Many of the debates in the literature about SBE hinge upon the implicit, and sometimes explicit, assumptions about how change occurs in education settings. Research has shown that filtering federal policies down through many tiers of government takes time and results in variation as each district, school and teacher interprets the policy differently (Cohen & Ball, 1990; Odden, 1991). Despite these persistent problems with educational policies and their weak relationship to teachers' classroom practices, policies continue to issue forth from federal and state governments. One reason for the proliferation of policies from government is summed up by Lipsky (1980):

> [I]t seems easier (although it actually may be harder) to change workers' behavior or approaches to their jobs than to affect the political system that structures the jobs. Clients and client groups appear to have a better chance to reorient (reeducate?) individual street-level bureaucrats in a single facility or field station than to affect the general patterns of recruitment, budget making, and policy establishment that condition the work. (p. 184)

Lipsky's comments speak to the inability of legislated policies to substantially alter teachers' practices because they only address a small part of a large educational system, and they are typically "top down." It is difficult to effectively change teacher practices by applying pressure from outside the classroom in a top down fashion, yet attempts regularly are made. Perhaps this is because it seems easy (as Lipsky notes) or perhaps this is due to lack of other controls. Teachers operate relatively autonomous from their principals and other teachers in their schools, therefore it is very difficult to manage their work. Given a lack of avenues for direct control over teachers' classrooms, issues of quality of teacher service are translated into issues of accountability. In other words, since we can not directly control what teachers do in their classrooms, we rely on outcome measures such as student performance as accountability measures – i.e., as indirect control over what goes on within the classroom.

It is also difficult for teachers to change their own classroom practices through bottom up reforms. One reason is that teachers' practices are routines that they have established to cope with their daily realities of too many students and not enough time or resources. These routines are not easily changed because teachers view their coping mechanisms as virtual job requirements. Another reason is due to a dilemma inherent in the role of a teacher. On one hand, society wants teachers to be compassionate toward their students and to have the latitude to exercise their judgement as professionals. On the other hand, society wants standardization and adherence to

rules and policies. Without changing these circumstances, even a bottom up policy is hampered in its ability to bring about reform.

Fullan's (1991, 1996) theory of change states that teachers' understandings of SBE must be clear and aligned with the intent of the reform if changes in curriculum, instruction and assessment practices are to occur in their classrooms. Instead of making their work more fragmented or further overloading them, teachers must perceive the suggested changes as coherent and a way to simplify their work. Additionally, reform activities can not be viewed as "add-ons" to their regular work. A seemingly clear sign of incoherence is when reforms are suggested without evidence of sustained support from state and district leaders in the form of resources. Teachers cannot be expected to invest their own time and energy resources when the external supports do not exist (Odden, Anderson & Farrar, 1986).

Both Fullan and Lipsky argue for a teacher-based approach to any educational reform. Fullan makes a convincing argument that reforms typically start with ill-conceived assumptions about the realities of being a classroom teacher, and that this initial mismatch between the assumptions and the reality is a fatal flaw. Both of these authors are convinced that the only way to effect educational change is to look at the reform and the needs from the "receiving end or shopping end" (Fullan, 1996, p. 349). That is, we must consider where the teachers are, what the needed changes are from their perspective, and how to implement these changes from the classroom perspective. Teachers in different types of school districts face different daily realities, and this explains, in part, why reforms take hold in some places and flourish, but the same reform in another place fails (Lipsky, 1980). Can we assume that teachers in affluent districts do not have to grapple with issues of poverty and, thus, are free to pursue opportunities for reform while those in poorer districts do not enjoy this same freedom? If the reform takes poverty and other issues into account and makes a legitimate effort to confront them (e.g., more support and/or resources are provided to poorer districts), we might expect the impact of economic differences to be mitigated. However, when no legitimate efforts are made to account for these differences, we can expect disparity in both implementation and impact on student achievement along socio-economic lines.

Surface level changes to districts, schools and classrooms are not sufficient responses to the reform, as NCTM envisions it. "It is all too easy to agree with the rhetoric of reform but still

maintain long-held beliefs or practices inconsistent with intended reform practices" (NCTM, 1989, p. 255). Cuban (1988) differentiates between surface level, 1st order, and deeper levels, 2nd order, changes. He notes that 2nd order changes are more complicated and therefore harder to implement; however, they also are more likely to result in lasting impact.

Rationale and Purpose of This Study

Based on the literature cited above, it would be imprudent to assume that a district's formally adopted standards-based curricula will automatically translate to enacted classroom curricula. Such a trickle-down theory of educational reform is not realistic because it does not address barriers to change, such as the interface of the reform with teachers' daily work. The purpose of this study is to explore how two Colorado school districts actively engage in and implement SBE reform. The variables considered important in this study include the educators' understanding of the reform and the changes in their curriculum and instructional practice due to the reform. This study proposed two hypotheses at the outset. First, many teachers do not have sufficient understanding of the reform and therefore can not fully implement it. Second, teachers' SBE reform efforts will be limited by the extent to which they face other pressing problems in their schools.

Research Methods

The research design is a case study of two Colorado school districts, Northern District and Eastern District. Data were collected during the 1996-97 school year. The multi-site design allows for analysis of the impact of SBE in different settings and still produces over-arching answers to the research questions (Garaway, 1996).

Site and Participant Selection

Of Colorado's 176 school districts, a reputational sample (LeCompte & Preissle, 1993) of four districts participated in the larger study, and this paper reports on two of the four sites. (Analysis of the other two sites is in progress.) Reputational sampling, or sampling based on the recommendations of experts, was chosen because other sampling strategies, such as random sampling, might not be practical due to the low incidence of serious SBE reform efforts in Colorado districts at the time of site selection. A criterion for district selection was that each site

demonstrate SBE implementation activity, else there would be nothing to study. Another common form of sampling, stratified random sampling, was considered with stratification along the lines of SBE implementation progress; however, implementation characteristics of the population of all Colorado districts are not available.

For the reputational sample recommendations, experts were identified as groups of people with broad knowledge of Colorado school district activities. Experts were asked to consider dimensions of size, socioeconomic status and setting, and to endorse one or more districts actively pursing SBE within these categories. Although experts were not asked to consider convenience as a criterion, it is reasonable to assume that this was a factor in their recommendations because eighteen of the nineteen endorsed districts are within 3 hours driving time from Boulder. (In Colorado, some districts would have required up to 8 hours of drive time.) Of these nineteen districts, four participated in the larger study.

In the two districts reported on in this paper, the researcher requested the Director of Testing and Assessment to recommend an elementary, middle and high school that was pursuing SBE implementation. Through the principals, each school was asked to participate, and all agreed. Within each school, principals were asked to nominate at least two teachers typical of those in the school. The rationale for selecting typical teachers was to find out whether SBE reform was typical for teachers in leading districts. In most schools more than the minimum of two teachers participated. Other teachers were identified by their peers, i.e., snowball sampling (LeCompte & Preissle, 1993).

Data Collection

Sixteen participants were interviewed at Northern: the Director of Assessment and Testing, three principals (elementary school, middle school and high school), and twelve teachers. Eighteen participants were interviewed at Eastern: three central administrators, three principals and twelve teachers. The interviews were structured, i.e., a standard interview protocol was developed and used as a guide to ensure that all major topics of interest were covered.

After each teacher interview, one math class was observed with the idea that the teacher could then demonstrate examples of what was discussed during the interview. The observation was not for the purposes of judging their ability or evaluating their classroom. Teachers were

specifically asked if and when the researcher could visit their classroom to observe them teaching the math standards. Teachers often, as they spoke aloud, indicated that they were selecting specific days that would be good and eliminating other days for various reasons, including guest speakers, tests, etc.. During each observation, samples of worksheets, assessments, and student work pertinent to that day's classroom activities were collected and fieldnotes were taken. Additionally, at each district several professional development workshops related to SBE were observed, artifacts were collected, and fieldnotes were recorded. Numerous other district documents also were obtained, reviewed and cataloged.

Data Analysis

Interviews were tape-recorded, transcribed and analyzed using Non-numerical Unstructured Data Indexing, Searching and Theorizing or "NUD*IST" software. Domain analyses were conducted on all interview transcriptions. Preliminary assertions and relationships in the data (Miles & Huberman, 1994; Spradley, 1980) were culled by first separating the data according to the major interview topics (e.g., interpretation of SBE) which served as the initial domains. These domains were used with all transcripts. A random sample of 10 interviews (five from each of these two districts) were selected for the next round of analysis which generated sub-categories within each domain. During this process the coding was refined so that categories that were too narrow were collapsed and ones that were too broad were sub-divided. Once these sub-categories were identified and clearly defined in an on-line data dictionary, they were applied to all other interviews. An additional category, called "other", was defined to capture pertinent interview comments that did not fit into these emergent codes. Upon completion of coding, the "other" category was examined to determine if it could be renamed.

After domain analyses and coding of the interview transcripts, these domains were used to code and classify teacher-made documents. District-made documents were coded separately and turned out to be most useful for policy and background information. Documents and artifacts collected from each building were analyzed as a group. Due to the large volume of documents collected, this was a feasible way to manage the data.

Interview comments within the large domains of "SBE interpretation" and "curricular and instructional changes" were summarized. These results were compared to the document analysis

results. This analysis was undertaken with attention to reconciling rhetoric with supporting evidence. The rationale was to compare the national vision of SBE reform to the teacher's vision, and then to compare these two visions to the evidence from the classroom.

Results

This section first briefly describes each district's demographic information and SBE policies. Following these introductions, results are reported as they fall into the domains and sub-domains used for analysis. Within each domain, results for each district are included, and differences among levels (elementary, middle, and high school) are noted when they exist.

Setting 1: Northern School District

Located in a small city, Northern School District is a mid-sized district serving between 10,000-20,000 students. The percentage of minority students is smaller than in the state as a whole (about 10% in Northern compared to 27.5% statewide). The percentage of students qualifying for free and reduced-price lunches is comparable to the state average of 13%. Also, the dropout rate is comparable to the state average of 4.4%. Northern is reputed to be the SBE leader in the state, having had standards in place since about 1990 for six content areas (reading, writing, mathematics, science, history and geography) and in 1997 adopting content standards for another six subjects.

Northern District's assessment system is comprehensive, with mandated assessments for all students in kindergarten through 10th grade, yet not progressive. Several grade levels take the Iowa Test of Basic Skills (ITBS) every spring. Additionally, elementary and middle school students take commercially prepared, criterion-referenced tests. These multiple choice tests are used to mark student progress but are not used to retain students. Testing becomes high stakes at the high school level. For high school students to receive credit for a course, they must pass a "proficiency" test as well as receive a grade of D or better. Similar to the tests at the lower grades, proficiency tests usually consist of multiple choice items, except in writing and oral communication. This semi-high stakes system allows all students to progress into the high school but prohibits students from graduation until their performance is at least acceptable on the district's standards. Northern's standards include the state's six content standards plus several

additional areas: humanities, work skills, sense of community, self-esteem, responsibility, interpersonal relationships, persistence, motivation, intellectual curiosity and ethics.

On the 1997 Colorado Student Assessment Program, Northern 4th graders performed higher than the statewide averages in both reading and writing. Northern historically has performed, and continues to perform, much better than national averages on the ITBS as well.

Setting 2: Eastern School District

Eastern School District serves between 5,000 - 10,000 students, over half of whom are Hispanic. Located near a large city, Eastern has one of the highest dropout rates and one of the lowest graduation rates in Colorado. Approximately 60% of students in the district qualify for free & reduced-price lunches. Although Eastern's standards span several academic areas, the district's primary foci are to improve literacy across all grades and to keep students in school. Other pressing problems facing the district are a lack of parental involvement, high student mobility, and high teacher turnover.

Yet despite these statistics, Eastern is a leader in SBE reform in Colorado. As early as 1987, Eastern staff and community members deliberated about what students should be able to do when they graduate from high school. During the next several years, Eastern steadily progressed: in 1990, it developed standards; in 1991, it adopted standards and developed benchmarks; between 1992 and 1995, it piloted and refined several standards. When the state adopted its model content standards, Eastern was consulted for advice. Eastern's standards include the six content areas of the state's models, as well as standards for personal effectiveness and social responsibility, among others.

Assessment in Eastern has not progressed as rapidly as the early adoption of standards might suggest. National standings reflected by the Comprehensive Test of Basic Skills (CTBS), the primary measure of district achievement and accountability, are very important in the district. In fact, one of the district's goals is to improve student achievement as measured by an annual percentage increase on the CTBS until certain scores are achieved. In addition, the district administers its own writing assessment annually to four grade levels. This writing assessment, both criterion-referenced and standards-based, is more progressive than the CTBS. To measure student achievement of standards, Eastern has compiled specific classroom performance

assessments to be used in specific high school courses. Each assessment is tied to district standards. By passing a class, a student has necessarily met the standards associated with that class.

Proficiency on the standards is high-stakes for Eastern students. Beginning with the Class of 1997, Eastern high school graduates are held accountable for a growing body of standards. At lower grade levels, student attainment of the benchmarks determines their progression from elementary to middle school, and from middle school to high school and thus is high-stakes also. Students at these levels can advance from grade to grade within their buildings but transitioning to the next building is based upon their proficiency.

On the 1997 Colorado Student Assessment Program, Eastern 4th graders performed much lower than the statewide averages in both reading and writing. Eastern has historically performed, and continues to perform, well below national averages on the CTBS as well.

This background on each district's SBE policies provides the context for the following presentation of teachers' understanding of SBE reform and their subsequent classroom changes in curriculum and instruction. The findings are presented according to analysis domains, and comparisons between Northern and Eastern are made within each domain. This type of presentation eliminates the redundancies that occur in discussing each site separately. These findings suggest that there is great variation among teachers within each of these leading districts in terms of their understandings of SBE, and that this variation carries over into their classroom practices.

Interpreting SBE

Although there was a range from very simple to very complex interpretations of SBE reform, the majority of teachers reported simplistic understandings. Overall, teachers fell into three groups: 1) those misinterpreting the reform as a simplistic change, and not being troubled by the change; 2) those recognizing that the reform requires a more complex change, but misinterpreting it and being troubled by it; and 3) those recognizing that the reform is complicated and embracing it in their classrooms. The data reflect a difference between the districts. In Northern, most teachers offered a surface-level interpretation. In Eastern, there was

more variability in the type of responses. In addition to the simplified renderings of the policy, some Eastern teachers offered more complex versions of SBE.

Some examples of surface-level interpretations include that standards are simply a way to reorganize teachers' work into the six broad categories of the standards; standards merely "give a new name to old practice"; and standards are a new curriculum provided by the state. For example:

> Really, to me, I think it means guidelines that I know where the students need to be, where I know I can align my curriculum to. Really at this point I think that's all it is. Its guidelines as far as graduation and things like that. But I really think it's just a way to align your curriculum to what the students need to know. (Northern elementary school teacher)

And:

> When I saw the standards I thought, "This is what I've been doing for 34 years! They are not that different." Our school district has always had a course of study, which outlines what they really anticipate 3rd graders knowing under my care. In the course of all my teaching, most of everything you would see on the standards are things that I have been doing in the classroom for a long time. (Northern elementary school teacher)

The latter quote is more meaningful in light of this 3rd grade teacher's classroom activities. Math class on the day of my observation consisted of Mrs. Peterson, the teacher, using an overhead to demonstrate how to use groups of ten to add. After a fifteen-minute overhead demonstration, Mrs. Peterson allowed time for student group work. Students completed group worksheets that asked them to count items lined up in columns of ten. Often, the problem contained fewer than ten items in the last column. The 3rd graders were to use the fact that there were 10 items in each full column and skip-count by columns (10, 20, 30, etc.) rather than count each item individually. The students worked with their group to come up with their answers and complete the worksheet. After this activity, the teacher led the class in sharing each group's answers. [Classroom observation, 10/96]. The activities in this math class, which Mrs. Peterson felt was a good example of addressing the district's math standards, combined with her comments above regarding the meaning of the reform, indicate that her interpretation of the reform falls short of NCTM's intentions for the reform.

For other teachers, SBE is a "quick fix" to problems by the state, lacking meaningful support:

> *Gloria:* I fight the thought that this is just a trend because we're always in trends....And I wonder with this too how much of it is a trend. I think there are definitely some good things that are coming through but I also feel like with some of it we're just jumping through hoops and its just a trend.
> *Becky:* Yeah, I think there could be a lot of good come out of this but I certainly don't see the money supporting what we need to do. If we're really going to support this we have to have time, a lot of time and I don't see that happening.
> *Gloria:* I don't see that the state is going to be able to pull this off because of the money.
> *Becky:* A similar thing is happening in the licensure. ... It's hard to believe there's any value to it when you know they're not putting the money out for it.
> (Dialogue between Northern high school teachers)

While some Eastern teachers shared the simplistic views described above, most (eight) Eastern teachers reported a more complex, although not always accurate, understanding of the reform. For example, three Eastern teachers said that SBE calls for a huge shift in their teaching, completely away from computation and toward problem solving. They felt that SBE is a swing in the educational pendulum, which goes too far toward "touchy, feely" math. One reported that the de-emphasis of computation at the middle school is not acceptable because students do not currently spend the elementary school years "doing the back to basics stuff, just hard core drill it, drill it, drill it." Such rote activities, in her opinion, would provide the foundation for the middle school curriculum to address mathematical applications. A high school teacher uses the analogy of a basketball game:

> SBE can become just another swing of the pendulum, the educational flavor of the month. There's a real danger of losing skills. I think you could say the same thing about basketball. It used to be that the way people learned to play basketball is to run drills and shoot free throws. Now, all kids do is play scrimages, just play the game. It seems to me that it's better to have a balance.

Another group of (four) Eastern reported a grasp on the policy as envisioned by NCTM coupled with more positive stances toward it. These teachers, who spanned all levels, reported that SBE implies a more meaningful mathematics education for students with a goal of ensuring that "real learning" takes place. The following excerpt illustrates this point:

> The students that have accepted the change and believe in what we are doing, have gone way beyond where they were before in understanding mathematics. So the successful

> students are getting more powerful, better prepared for problem solving in the future. Another positive aspect is that I feel we can get more students to the point where they have a solid understanding of mathematical concepts. ... Another positive aspect of the standards is that it opens up their eyes to possibilities with math. (Eastern high school teacher)

The only teacher to mention that SBE called for a fundamental change in the roles of the teacher and students came from Eastern. She felt that SBE implied a shift from a teacher-centered classroom to a student-centered classroom where students were responsible for their learning rather than being "bottle-fed" the material. This teacher also said that she regularly was subject to student and parent complaints because they did not like her approach to education.

Curriculum and Instruction Changes

The predominant types of changes teachers reported in their classroom activities were: 1) emphasis on problem solving instead of "basic" skills; 2) integrating math with other content areas and relating this to real life situations; 3) covering new mathematical topics and using new technology; and 4) re-organizing material. The paragraphs below describe and provide examples of these changes as well as illustrate the variation of responses from teachers.

Problem solving and "basic" skills. While teachers in both districts commented about the new emphasis on problem solving, Eastern teachers were much more likely to mention it (12 Eastern and 4 Northern teachers). Concerned about students' ability to compute or their grasp of "the basics" surfaced during interviews with Eastern teachers about three times as often as it did with teachers from Northern.

In the classroom, Eastern focused much more exclusively on problem solving skills and calculators for computation than did Northern. Thus the expressed concern of Eastern teachers is not without cause. These teachers were concerned that students were not getting enough time practicing computation and other "basic" skills. Eastern addresses this at the middle school level by requiring students to take two math classes every year, one computation class and one application class. Two middle school teachers describe this problem and its current solution:

> *Samantha:* They have two math classes, one is computation class where they do 6th grade stuff: fractions, decimals, percents, number manipulation. Then their 6th grade interactive class is where we apply it and do the problem solving.

> *Michelle:* That's the old back to basic, worksheets, a lot more of here's 20 problems and if they're not done they're homework. Whereas the interactive is more word problems, problem solving, group work.
> *Samantha:* They don't have their multiplication tables memorized, so they can't go back and forth between multiplication and division in their heads quick enough to realize that relationship. That's a concept they don't get.
> *Michelle:* I honestly believe there is some good with the rote memorization of the multiplication, division, even addition and subtraction tables. ... The basics have got to come in there somewhere.
> *Samantha:* I just did a warm-up problem of 13 + .75 and well over ¾ of my 8th graders put the answer was .88. Very few of the registered that 13 is a whole number and it goes in front of the decimal and you line up the decimals before you add. I personally spent three weeks on adding and subtracting decimals at the beginning of the year.

The district's policy of two math classes at the middle school, one for computation and the other for higher-order skills, is not aligned with NCTM's call for an integrated mathematics curriculum.

The concerns of teachers at Northern, where students have historically performed well on standardized tests, about computation were much different. Here, teachers were not worried that students could not compute but, rather, that computation did not have meaning for their students. In an effort to resolve this, they try to stress the conceptual reasons behind each computation instead of approaching it from a strictly algorithmic standpoint. For example:

> Well, why is the decimal point counted over there? Why do you line them up this way? Because you're adding columns that are the same size portions. Its like going back and re-discovering why the rule works so that they can remember the rule. (Northern middle school teacher)

Although approached from a more meaningful stance, extensive computation practice was still included in lessons at Northern. "Multiplying by the inverse of fractions? We did 100 problems like that yesterday" (Northern middle school teacher). Teachers in both districts believed that students need to maintain their computation skills through repeated practice.

Integration and Relevancy. Although teachers in both districts (9 Eastern and 9 Northern) have incorporated written communication in their math courses, classroom observations and teacher-made documents (assignments, syllabi, etc.) indicate that integration of math with other subjects occurs only at the elementary level. The one exception to this is at Eastern High School where two math teachers work with two science teachers to integrate across their content areas. However, this produces logistical problems, as described below in "organization and management."

At the elementary level, teachers have long emphasized integration across the curriculum and so this aspect of SBE reform dovetails with their tradition. One Eastern elementary teacher explains how this has been an established routine necessary for managing the breadth of the elementary curriculum, "There's so much that if you don't try to teach smart, and combine things, you're never going to get all this done." At the middle and high schools in both districts, teachers have added an aspect to all math classes called problems of the week or POWs. POWs require both problem solving and clear explanations of the process and solution. Teachers report that students initially resisted fulfilling writing requirements for their math courses, but are beginning to get accustomed to it. The variation among teachers is evident in this area of the reform as well. Some teachers found it valuable to incorporate writing into the math curriculum, while others saw it as intruding on their math time.

For some teachers, connecting math to the real world was the primary reform. One avenue teachers use to increase relevancy is to illustrate the relationship between mathematical power and career opportunities. Commonly, teachers invite community members to class to talk to the students about how they use math in their jobs.

New Math Topics and New Technology. Many Northern (10) and fewer Eastern (3) teachers mentioned the addition of statistics and probability to their curriculum. This may be explained, in part, by the fact that in 1995 Eastern adopted a districtwide integrated middle school and high school math curriculum that incorporated statistics and probability. At the HS level, Northern teachers frequently reported that they resolved the problem of not covering statistics and probability by squeezing in additional units into the semester. Although statistics may have been the topic of an existing elective math course, it was not part of the mainstream required math courses. At Northern, the math department addressed this omission by inserting a new unit in the Algebra II course that meets the probability and statistics standards. However, teachers complained that this takes time away from covering other topics:

> So now our algebra II classes don't teach something else so that they could teach statistics in that class. ... We still have a statistics class. So that helps the algebra II kids who never see a statistics class but it repeats a lot of stuff for kids that go from algebra II to a statistics class. So, it's a give and take. You're helping some kids but you're wasting other kids' time.

Visits to classrooms and review of syllabi documented this practice of teaching statistics and probability as an isolated topic rather than integrating these concepts with others.

At the elementary levels, teachers report having to drop some topics, for instance basic arithmetic, to make it possible to either cover topics not previously addressed or provide a more in-depth coverage of currently included areas. Some teachers complained that they had to drop their favorite special units due to lack of time.

Technology in the form of graphing calculators and computers is becoming more common in mathematics classes in both districts, demanding they invest in equipment. At Eastern, each math teacher has a classroom set of graphing calculators that are available for checkout and use during class time. "It seems like standards have kicked a few people in the pants to get technology here more. The community has accepted it and we've passed a bond. I think this has pushed a lot of people to see that technology is important." (Northern middle school teacher)

Organization and management. Very frequently, teachers reported the impact of SBE on the management or organization of the curriculum (9 Northern and 7 Eastern). Using Venn diagrams referred to as curricular maps and unit organizers to manage and organize the volume of material was cited by several as a primary change due to the reform.

> This is one of the unit organizers we're using. And then we're using lesson organizers and ... what's the third one, help me out... oh, course organizers. The other thing is we all have the standards up on the wall so that they're easily accessible and you show the kids what you're doing. (Northern middle school teacher)

Teachers felt that this was a critical element enabling them to cope with the new reform policies. The intent of these organizers is to track the relationships between particular curricula and standards. This enables teachers to manage the volume of standards. Using these tools, teachers can determine which standards are "covered" by which units, which standards have not yet been "covered", and which units do not address any of the standards. Such streamlining of the curriculum is encouraged by administrators.

Teachers also use these organizing tools to document that they have in fact covered the standards in their lessons should this be necessary for their own performance evaluations.

> I am going to try going through old lessons and to go on with new lesson plans. I'm going to try to say these are the standards and as I meet them I'm going to write them down on these blank pieces of paper. Then I can say, for the week of October 28 these are the standards I covered. (Northern teacher)

Evidence from the classroom supports that teachers were committed to documenting how everything they taught referenced the standards. Every teacher who mentioned the use of these organizational tools provided at least one example of a completed form and explained how to interpret the diagram.

Keeping track becomes even more complicated at the secondary level where students may be addressing science standards in a math class, but not even taking science. It becomes an issue of which teachers have authority to claim that a student has achieved a standard in another discipline and how to inform the appropriate teachers of students' status.

> It's going to be a scheduling thing. I think they're just going to have to say that when they take math, they take a certain science at the same time. ... As we went to the standards there was all this bookkeeping with these little slips we had. That system wasn't working so they went to embedding certain standards in classes. (Eastern high school teacher)

At Eastern, these decisions about student achievement on particular standards have been simplified by associating each standard with specific high school courses. Successful completion of a course necessarily means that the student has attained all standards associated with that course. This eliminates confusion between Carnegie units and proficiency requirements, as well as providing an efficient way to track students' standards-based progress.

However, at Eastern even the best organizational tools are not going to solve one of their biggest problems, student absenteeism. This problem was hard enough to handle before the advent of SBE, and the additional emphasis on individualized student learning makes management practically impossible.

> I usually have 15-20 on the rolls and there are usually about 10 here. It sounds like a nice sized class but it really is a drag. You'll have 12 kids here one day and 8 different kids the next day. It just gets out of control real quickly. (Eastern alternative high school teacher)

> The classes can run in size from about 20 to 35. The problem, of course, with that is the tremendous attendance problem here. With the tremendous attendance problem here at Eastern High, I can have anywhere from 15-20 students present....In one class a few weeks ago, I had 18 absent out of a class of 24, which is 75% absent. That makes it very difficult to get the kids caught up. (Eastern high school teacher)

Minimal Changes. One final and very important category of teacher responses has been coded "minimal changes" and contains comments of those teachers (5 Northern and 3 Eastern)

that did not feel that SBE had impacted their classrooms much so far, and were skeptical that it ever would. Several teachers stated that they have not yet made any significant changes in what they teach or how they teach. Some felt that these things may change "as standards become more a part of my life", but that SBE had not yet impacted their classroom. Some took comfort in the state model content standards, reading them as a checklist and concluding that "what we were already doing – which was the astounding thing I think – we're already doing them. I mean there are very few standards in all of these areas that are totally new to us. ... So then you were relieved."

At the high school level, at least one teacher felt that using a new integrated math textbook met the spirit of the reform.

> In the integrated I and II, when we looked at how the curriculum matched the standards, it matched real well. In fact, the integrated I and II books hit all six standards. ... So we haven't made sweeping changes in our curriculum because it looks like we're already teaching the standards in the integrated math. (Northern high school teacher)

In fact, when this particular high school teacher was observed, he used the integrated math textbook and still managed to maintain a traditional teaching style. He simply covered the material in the text in the order in which it appeared. His syllabus contained chapter by chapter assignments – which were more than just computation to be sure. However, much of the philosophy of the reform was lost in this classroom where SBE was translated as a new textbook and nothing more.

At Eastern, two elementary teachers recognized that SBE called for changes but, because they do not have access to the necessary materials, have not significantly changed their practices:

> As far as I'm concerned I haven't changed a lot since the standards came out. We've basically always done the same thing. ... We don't have enough material, of the supplemental stuff yet, so ... I think that what I was hitting 6 years ago is what I'm hitting now. It's just recording it differently. That's my feeling. (Eastern elementary teacher)

> I think the hard part is just the materials. When you don't have that its tough to do. With the standards the way that they are and the portfolios, it's a big key. They're asking us to do something and we don't have the supplies to do it. (Eastern elementary teacher)

Conclusions

It is apparent that there was great variability among teachers in these leading school districts, even after several years of having standards in place. Teachers' interpretation of the reform ranged from perceiving SBE as a curricular checklist to understanding it as an intensive change in the way classrooms operate. In Eastern, some teachers perceived a call for Cuban's 1st order surface level changes and others a need for 2nd order fundamental changes. In this district, teacher curricular and instructional changes reflected this variability. In Northern, teachers' understandings of the reform were more uniformly of the 1st order (with some exceptions of course), and their classroom practices were also more uniformly of the 1st order, such as a shift away from context-free math problems and toward word problems posed in real life situations. Surface changes are certainly a step in the right direction but it is not sufficient to stop there.

Both districts continued to administer nationally normed, standardized achievement tests each spring. Teachers in both districts were concerned about their students' abilities to compute and required students to frequently practice computation on large numbers of problems. In fact, Eastern middle school students took two math classes, one of which was devoted to computation. In Northern, teachers attempted to provide students with an understanding of computation procedures when assigning practice problems.

Across educational levels, there were differences and similarities in implementation. Elementary teachers were more likely to integrate math with other subjects in the curriculum than were middle school and high school teachers. High school teachers also were apprehensive about integrating traditionally separate math topics, such as algebra and statistics. The use of technology, usually in the form of calculators, was common at middle school and high school levels in both districts. Across all levels, the integration of math with writing was the most prevalent form of cross-curricular integration.

There are several possible explanations for these findings. One insight is that it takes a change in teachers' frames of reference to succeed, and this does not happen automatically or easily. Teacher understanding is crucial if this is to infiltrate the classroom. Perhaps teachers have not been clearly informed about the impact this implies on their instructional practices and the expectations for change. Teachers need to be educated about the expectations of the SBE policies as envisioned by NCTM and prominent mathematics education researchers. They also

need time to process the implications of this reform, to plan their new lessons, and to practice and refine these changes in their classrooms.

Alternately, perhaps the message to teachers has been clear but teachers have chosen to interpret it as a simple change because this is more manageable for them given their workload and other pressing problems in their schools. Eastern School District faces problems of poor attendance, too many drop-outs, and high rates of staff turnover, issues rarely raised at Northern, the higher income district. One Eastern administrator draws a comparison to a more affluent district and notes that students in that other district can achieve these standards regardless of whether the educational system truly changes there. In sharp contrast, many parts of the educational system need attention in Eastern School District for students to measure up to these standards. If teachers see SBE reform as an education fad lacking the necessary support for success from educational leaders, i.e., if the change seems fragmented to them, it is reasonable for them to simplify or reject it.

These findings suggest that in order for SBE reform to significantly impact math classrooms, states and districts will need to provide: 1) more opportunities for teachers to understand NCTM's vision of SBE reform and acquire the skills to implement it; 2) time to make such fundamental changes; and 3) assistance to alleviate other pressing problems, particularly in traditionally lower achieving, lower socio-economic districts.

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